DEPARTMENT OF ENERGY ATMOSPHERIC SCIENCE PROGRAMS

For nearly 50 years, the Department of Energy (DOE) and its predecessors, the Atomic Energy Commission and the Energy Research and Development Administration have supported meteorological operations and atmospheric research at the DOE field offices. The need for meteorological services began with the development, fabrication, and testing of atomic weapons and the national security and safety issues associated with them. In addition, environmental protection legislation specifies requirements for meteorological services to protect public health and safety and the environment.

The Department of Energy (DOE) is a leading science and technology agency. Its research and other activities support our Nation's energy security, national security, environmental quality, and contributes to a better quality of life for all Americans (*http://home.doe.gov*). Atmospheric science research and operations have been an integral part of DOE's (and its predecessor agencies') science and technology mission component since the Cold War era. It is essential to understand the nature of the atmospheric domain and how energy use influences its attributes. Today's global climate change issues/outcomes will rely on information obtained through basic, atmospheric science research programs that one day will reduce substantial uncertainties in these areas.

DOE coordinates programmatic activities through its Offices of Defense Programs, Science, Environmental Management, and Energy Efficiency and Renewable, to name a few. These offices are responsible for the management of scientific research programs such as the Atmospheric Release Advisory Capability (ARAC), the Atmospheric Radiation Measurement (ARM) Program, and various clean up activities at former production sites.

Meteorological services at DOE facilities range from complex research and development programs to providing daily operational support. Some examples of research and development are investigations of potential global climatic change, radiation studies, and studies of atmospheric processes. Operational support programs include daily customized weather forecasting services, special project support, onsite meteorological monitoring programs, climatology services, and emergency response program assistance. Some DOE sites maintain 24-hour weather watches for severe weather conditions that could impact site operations, damage property, or threaten lives.

Several DOE field offices, such as Idaho (Idaho Falls, Idaho) and Savannah River (Aiken, South Carolina) Operations Offices cover large areas, and some sites contain complex topography and heterogenous surface characteristics, creating locally driven conditions that influence on-site weather. For these reasons and to protect public health and safety and environment, on-site meteorological monitoring has been and remains an essential part of DOE atmospheric science programs.

Some DOE sites contribute to the national weather observing network by taking standard surface and upper-air observations. Many of these sites are in remote areas where weather observations would be sparse if not for the presence of DOE meteorological monitoring programs. Weather observations taken at a few DOE field sites are entered into the national weather database via the National Weather Service (NWS) meteorological data distribution and display system. This distribution and display system interconnects field offices and serves as the distribution system for NWS meteorological products that are centrally produced by the National Centers for Environmental Prediction (NCEP). Other DOE sites employ Automation of Field Operations and Services (AFOS) units connected to the NWS AFOS network through NOAA's Air Resources Laboratory (ARL), Las Vegas, Nevada. NOAA's ARL supports the DOE/Nevada Operations Office and serves as the hub for the NWS/DOE AFOS network.

An accidental release of radioactive or toxic material into the atmosphere can have potentially serious health and environmental consequences. Meteorological processes play a key role in determining the fate of pollutants released into the atmosphere. For example, the processing, fabricating, and underground testing of nuclear weapons all have the potential for industrial accident scenarios. In addition to these activities, the use of nuclear material in the generation of electric power and the storage of nuclear waste from power generation, weapons' complexes, and medical and commercial processes are all potential sources of nuclear material that could be accidentally released into the atmosphere. Consequently, a central theme within the DOE community has been to protect public health, safety, and the environment on and around DOE facilities. Therefore, DOE has required and supported on-site meteorological monitoring, directed the development of emergency response capabilities at DOE facilities, funded research on the modeling of the transport, dispersion, deposition, and resuspension of radioactive and toxic materials, and advocated on-site weather

forecasting services tailored specifically for the special operational and emergency management requirements at each DOE facility. Much of the research and most of the operational support has been provided by the atmospheric research programs at the six major field offices directly involved in national defense programs. Over the years, these programs have grown to address many environmental, safety, and health issues. Due to the complexity of these activities, it was recognized that efforts should be made to coordinate meteorological operations and research among the field offices to enhance cost effectiveness.

Based on a need to facilitate more coordination and cooperation among the meteorological activities at the DOE field offices, the DOE Meteorological Coordinating Council (DMCC) was created in December 1994. The mission of the council is to coordinate meteorological support and research to meet DOE objectives. The objectives of the council are to: (1) promote cost-effective support for all DOE facilities; (2) plan for future needs, requirements, and missions; (3) advocate awareness of atmospheric science applications and benefits to DOE; and (4) alleviate the use of common methods, procedures, and standards. The council is coordinated by a steering committee consisting of DOE headquarters and field element representatives and is currently composed of headquarters and field personnel and contractor managers of DOE site meteorological programs. Products of the DMCC include analysis of meteorological requirements embedded in DOE orders and guidance, site meteorological program peer reviews, and, as needed, customized technical assistance. Planned products include a DOE meteorological resource's directory, an updated meteorological requirement analysis, site meteorological program peer reviews, a DOE meteorological skill's matrix, and a bimonthly, E-mail newsletter.

The following narrative highlights meteorological activities at several DOE sites.

The Nevada Test Site (NTS) is managed by the Nevada Operations Office (NV). The NTS has been the Nations' underground nuclear weapons testing facility and is now used to support the sub-critical experiments and other national defense missions of the United States. The NTS occupies 1,350 square miles of south central Nevada and is approximately 75 miles northwest of Las Vegas. The topography of the NTS is complex with a system of dry lake beds and mountains. Elevations range from nearly 2,700 feet above mean sea level (MSL) to 7,600 feet MSL. The climate is arid.

Meteorological services are provided to DOE/NV by components of the Department of Commerce (DOC), National Oceanic and Atmospheric Administration (NOAA). The DOC has had a presence on the NTS for more than 40 years. During this time, NOAA personnel have built a solid technical reputation in meteorological operations in the nuclear weapons testing arena. Presently, NOAA support is provided by ARL, Special Operations and Research Division (SORD). SORD is recognized for expertise in the transport, dispersion, and deposition of radioactive and toxic materials and for developing a rapid emergency response capability for the unlikely occurrence of an accident resulting from the release of radioactive or toxic material into the atmosphere.

Both basic and applied research are carried out on problems of mutual interest to DOE and to NOAA. Emphasis is on the maintenance of meteorological support to national defense projects and to the stewardship of nuclear weapons. These capabilities focus on those facets of meteorology having a direct bearing on the transport, dispersion, deposition (fallout), and resuspension of radioactive and/or toxic materials. Other research includes documentation and study of extreme precipitation events, desert thunderstorms, cloud-to-ground lightning, and environmental issues related to air quality and visibility.

ARL/SORD provides full meteorological support to all DOE/NV operations on and off the NTS. Meteorology plays a key role in environmental, safety, and health responsibilities of DOE/NV. The SORD staff is responsible for conducting a modern program in support of nuclear and non-nuclear projects authorized by DOE/NV. Furthermore, the mission of SORD involves technical support to the emergency preparedness and response activities of DOE/NV, operation of a comprehensive meteorological monitoring program for the NTS, and provision of meteorological and climatological services required in support of DOE/NV and contractor programs at the NTS and elsewhere, as necessary. Personnel at SORD also consult with senior scientists and engineers at the DOE National Laboratories, NASA, private contractors, EPA/EMSL, USGS, USFS, and other NOAA laboratories.

The SORD meteorological monitoring network consists of twenty-four 10 meter (m) towers and two 30m towers. Wind speed and direction is measured at the 10m level on all the towers and temperature and relative humidity is sampled at the 2m level. Data from these towers are transmitted via microwave radio to a central processor that checks the data, creates data files, and archives the data every 15 minutes. The data files are accessed by microcomputer to create graphics products for operational use and for immediate display at 15-minute intervals. SORD also operates two 915 MHz vertical profilers on the NTS, one located in the middle of Yucca Flat and one at the Hazardous Materials Spill Center in Frenchman Flat. In addition, a NOAA full surface radiation budget (SURFRAD) station is operated and maintained at the Desert Rock Meteorological Observatory (DRA)

located in the southern part of the NTS. Upper-air soundings are taken twice daily, at 00 and 12 Universal Coordinated Time (UTC) from the DRA facility. SORD also operates mobile upper-air sounding systems and mobile pilot-balloon (PIBAL) equipment to support special projects requiring winds aloft data in real-time.

Large-scale meteorological data and NCEP weather forecast products are received via AFOS. SORD is the DOE node for distribution of NOAA/NCEP AFOS products. Other weather products supplied to DOE contractors, the National Laboratories, the NWS, and Nellis AFB include real-time cloud-to-ground lightning flash graphical products and local forecast products.

SORD provides meteorological monitoring support and project-specific weather forecast services to the Nuclear Emergency Search Team (NEST), the Federal Radiological Monitoring and Assessment Center (FRMAC), and the Accident Response Group (ARG) activities. Monitoring support includes surface and upper-air data collection and analysis. Weather forecast service entails maintaining a constant weather watch for conditions that might impact NEST/FRMAC/ARG operations and personnel, issuing site-specific mesoscale wind, stability, and weather forecasts, aviation weather support, and providing consultation to the On-Scene Commander and to National Laboratories personnel. SORD maintains a web site (*www.sordx.nv.doe.gov*) that includes graphical products that display current meteorological conditions on the NTS.

The Idaho National Engineering and Environmental Laboratory (INEEL) is managed by the Idaho Operations Office and is on 890 square miles of rolling, arid terrain in southeastern Idaho at the foot of the Lost River and Lemhi mountain ranges. Meteorological services and supporting research are provided by ARL's Field Research Division (FRD) with the mission to support emergency response exercises and INEEL operations with meteorological data, weather predictions, dispersion calculations, and consultation. ARL/FRD designs, arranges, and conducts field studies as needed to evaluate the performance of transport and dispersion models over local, regional, and continental scales, and to obtain high quality databases for the model improvement. They are recognized for their unique field experimentation capabilities, for expertise in conducting tracer studies, and for using direct and remote sensing technologies in support of tracer experiments.

To meet other mission requirements, ARL/FRD operates a large meteorological monitoring network to characterize the meteorology and climatology of the INEEL site. The network consists of 32 meteorological towers that provide wind and temperature data. The overall Meteorological Measurement Program is designed to provide representative data for the INEEL area to meet specific operational and potential emergency response situations. Most towers are 15m tall; however, three towers range from 45 to 67m in height. All towers are instrumented at multiple levels. Fourteen have relative humidity, precipitation, and solar radiation sensors. Continuous wind and temperature profiles are obtained from a 915 MHZ Doppler wind profiler, a Radio Acoustic Sounding System (RASS), and a Doppler SODAR. Wind profiles generally extend to 5,000 feet above ground; temperature profiles extend to 1,500 feet. All meteorological data are quality-controlled and archived for future use. Additional use of this database is made in operational weather forecasts tailored to meet INEEL and contractor requirements and to prepare climatological summaries that are distributed to users.

The Lawrence Livermore National Laboratory (LLNL) is located in a valley in California's Coast Range Mountains about 25 miles east of Oakland. LLNL covers approximately two square miles and is operated by the University of California for the DOE Oakland Operations Office. Two groups are involved in the atmospheric sciences at LLNL: the Environmental Protection Department (EPD) and the Atmospheric Sciences Division (ASD). EPD operates a 40m tower and supplies meteorological data for facility operations, regulatory compliance, and emergency response. Real-time and historical data are available via the World Wide Web (*www-erd.llnl.gov/metdat/*).

Within the LLNL Earth and Environmental Sciences Directorate, ASD conducts research on climate and weather processes on regional to global scales on the following issues: (1) understanding the transport, diffusion, deposition, transformation, and atmospheric effects of accidental releases or pollutants; (2) developing and testing models for the improved representation of physical processes in local- to global-scale atmospheric models; (3) understanding the uptake and removal of carbon dioxide emitted through fossil fuel combustion by the biosphere and oceans so that the effects of future emissions may be accurately predicted; (4) understanding the role of pollutants from fossil fuel emissions in determining greenhouse gas and aerosol concentrations and climate forcing; (5) understanding and predicting the extent to which stratospheric ozone may decrease because of anthropogenic emissions; (6) understanding and quantifying the natural variability of the climate system; and (7) understanding and quantifying interactions between the biosphere and climate.

These major efforts all stem from the need to predict the global and regional environment and its changing nature over the next few decades, so that policy makers will have the information needed for the formulation of rational energy-use goals.

Two major long-term programs within ASD include the Program for

Climate Model Diagnosis and Intercomparison (PCMDI) and ARAC. PCMDI develops and distributes software tools to facilitate model diagnosis and intercomparison, documents the features of models that are in use by the world climate community, and archives extensive collections of model output data. The PCMDI also provides quality global observational products for application as model validation data (*www-pcmdi.llnl.gov/*).

Since March 1979, LLNL has provided emergency response services via the ARAC program. ARAC is a centralized federal resource responsible to DOE, DOD, and other federal agencies under the auspices of the Federal Radiological Emergency Response Plan (FRERP). ARAC's mission is to deliver realistic, real-time, graphical, dose and exposure assessments to emergency decision makers to assist in the protection of populations at risk for releases of radiological and other hazardous material to the atmosphere. ARAC supports all elements of the DOE Emergency Preparedness and Response Program, including the NEST, ARG, FRMAC, and the Radiological Assistance Program (RAP).

ARAC maintains and operates the ARAC Emergency Operations Center that consists of redundant computer systems with uninterruptible power, automated continuous worldwide meteorological data acquisition, detailed worldwide terrain and geographic mapping databases, and a suite of three-dimensional, complex terrain, atmospheric dispersion models prepared to assess explosions, fires, vents, spills, or other releases of radiological or hazardous material. The ARAC Center is staffed by meteorologists and computer technicians with 24-hour on-call response. Part of the ARAC Program provides on-site and off-site emergency response services to about 40 DOE and DOD facilities around the United States via a dedicated Site Workstation System linked to the ARAC Center at LLNL. Each Site Workstation also collects on-site meteorological data from one or more towers. The response time for the delivery of an initial ARAC assessment is less than 15 minutes for a computer-linked site and 45-90 minutes for a non-computer-linked site. Since 1979, ARAC has responded to over 80 real-world events and conducted more than a thousand exercises with supported sites and agencies.

More information on the ARAC program can be collected at: *www-ep.es.llnl.gov/www-ep/atm/ARAC/arac.html* and an educational presentation of some past ARAC responses are located at *air.llnl.gov.* In FY 1998, ARAC began replacing its entire emergency response system with complete, state-of-the-art, high-resolution, terrain-following, variable-gridded, diagnostic, meteorological and dispersion model system including new user interfaces and 3-D graphical displays. In addition, the system will include a relocatable prognostic model that provides high-resolution 2-3 day forecasts in the region of interest.

The Oak Ridge Reservation (ORR) is home to four DOE sites: Oak Ridge National Laboratory (ORNL), the Y-12 Plant, the East Tennessee Technology Park (ETTP, formerly K-25 Site), and the Oak Ridge Institute for Science and Education (ORISE). Managed by the Oak Ridge Operations Office (ORO), the ORR encompasses nearly 100 square miles of hilly and heavily vegetated terrain in eastern Tennessee. Meteorological network systems which support day-to-day operations are managed and operated at the three main sites by Lockheed Martin Energy Systems, Lockheed Martin Energy Research, and Bechtel Jacobs Company. These network systems provide data that support environmental management (permitting, facility siting and environmental impact assessment), facility safety (safety analyses), emergency management (hazards and consequence assessment), operations (work planning), and substantial research.

The meteorological data acquisition program at the ETTP consists of two main towers (60m and 30m), six 10m, battery-powered supplemental towers, a SODAR system, an automatic lightning detection system that captures strike data from as far away as 100 nautical miles, a NEXRAD radar system and consoles, and a feed from The Weather Channel. The Y-12 Plant has two meteorological towers (60m and 100m) located at the east and west ends of the site. ETTP and Y-12 Plant meteorological data is fed into the ORR Emergency Operations Center (EOC) and at emergency control centers for hazard assessment, consequence assessment, and protective action recommendations. The data acquisition program at the ORNL consists of three (two 30m and one 100m) meteorological towers. Meteorological data is fed to an ORNL central computer system for analysis and dissemination.

The NOAA Air Resources Laboratory/Atmospheric Turbulence and Diffusion Division (ARL/ATDD) is located in Oak Ridge near the ORR. ATDD's primary mission is atmospheric research. Substantial research programs at ARL/ATDD are undertaken with the assistance of staff from ORISE/Oak Ridge Associated Universities (ORAU) and scientists from other national laboratories and organizations in the United States and abroad. ARL/ATDD also works closely with the ORAU to enhance educational opportunities in atmospheric science. ARL/ATDD research attention is focused on the physics of the lower atmosphere, with special emphasis on the processes contributing to atmospheric transport, dispersion, and air-surface exchange, and on the development and improvement of predictive capabilities using the results of this research. Many other projects are underway, such as surface energy bal-

ance and CO_2 exchange studies and long-term studies of CO_2 exchange aimed at process-level understanding. Operationally, ARL/ATDD personnel provide meteorological consultation and supplemental data for air quality analyses, environmental reports, and hazard and consequence assessments. Local climatological data are routinely collected and distributed. Under NOAA funding, ARL/ATDD operates a regional network of 15 towers ranging from the Cumberland mountains (middle Tennessee) to the Smoky Mountains on Tennessee's eastern border. Wind, temperature, and precipitation data are recovered every 15 minutes by telemetry and made available to users.

The DOE Kirtland Area Office manages Sandia National Laboratory (SNL). SNL is located between the Rio Grande Valley and Manzano Mountains adjacent to Albuquerque, New Mexico, and covers approximately 80 square miles of flat to mountainous arid terrain. Meteorological programs at SNL/NM include both support and research activities.

Meteorological services and support are provided through the Environmental Operations Center in the Laboratory Services Division. The mission is to provide meteorological support for various operations including: emergency response, environmental surveillance and characterization, and regulatory compliance. The monitoring network consists of six 10m and two 60m towers used to measure (1) wind speed and direction and (2) temperature and relative humidity. There are also three precipitation gages, two barometric pressure sensors, and one solar radiation pyranometer in the network.

Key research activities are provided through the Energy and Critical Infrastructure Center in the Energy, Information, and Technology Division. SNL/NM scientists are involved in the ARM program and the Surface Heat Budget of the Arctic Ocean (SHEBA). The ARM project is a combined measurement and modeling program. The goal is to gain a better understanding of clouds and their effect on atmospheric radiation with the final goal of developing better climate models. The SHEBA program addresses the interaction of the surface energy balance, atmospheric radiation, and clouds over the Arctic Ocean.

Los Alamos National Laboratory (LANL), operated by the University of California, under the responsibility of the Albuquerque Operations Office, is spread across 43 square miles (112 km^2) of the Pajarito Plateau at the foot of the Jemez Mountains that extend up to around 900m above the plateau. LANL is about 30 miles northwest of Santa Fe in north-central New Mexico. The Pajarito Plateau slopes to the east-southeast, dropping 400m across the laboratory, with canyons and mesas running along the slope of the plateau. The broad Rio Grande Valley lies to the east of the laboratory. Los Alamos has a semi-arid, temperate, mountain climate.

The operational meteorological program at Los Alamos operates a network of six towers (ranging in height from 23m to 92m), a monostatic Doppler SODAR, and three supplemental precipitation stations. Four of the towers are located on the Pajarito Plateau and are used to drive a diagnostic wind field for the program's plume modeling capability; a fifth tower is located in Los Alamos Canyon to give information on the larger canyons in the area; and a sixth tower was recently erected on top of Pajarito Mountain to measure ambient conditions. The SODAR gives information on winds up to the level of the Pajarito Mountain tower.

More than 100 instruments, consisting of over 20 different types of sensors, are used to collect data throughout the network. Variables measured by the program can be grouped into the categories of wind, SODAR-derived wind, atmospheric state, precipitation-related, radiative fluxes, eddy heat fluxes, subsurface measurements, and fuel moisture. Data collected by the network are checked for quality before their archival; raw data and real-time displays of graphs and tables are made available via the Internet.

The LANL Air Quality Group provides regulatory and environmental surveillance leadership and services to meet LANL air quality obligations and public assurance needs. The group develops and implements programs to ensure and address institutional compliance with state and federal laws related to air quality regulations, DOE orders for emergency management, air quality surveillance, dose assessment activities, and community concerns related to air quality issues. The group takes a proactive approach to managing air emissions by providing continuous air monitoring and measurement of external penetrating radiation on-site and off-site, coordinating LANL activities to ensure full compliance with air emission regulations, providing monitoring and modeling for emergency response, and assisting operating groups in developing and implementing new methods and systems to reduce emissions to as low as reasonably achievable. The monitoring capabilities of the Air Quality Group are supplemented by the field team within the Atmospheric and Climate Sciences Group, which operates various sensor systems including a unique Raman lidar system to obtain images of atmospheric water vapor distributions.

Research within the LANL Atmospheric and Climate Sciences Group supports DOE missions in both the defense and civilian sectors, such as work in the propagation of very-low-frequency sound ("infrasound") waves. Modeling studies contribute to understanding of propagation and, in particular, sources of infrasound. Just as it is possible to infer earthquake epicenters from seismic wave observations, infrasound sources can be

inferred from atmospheric observations. This work is an important component of monitoring compliance with the proposed Comprehensive Test Ban Treaty (CTBT). The CTBT work involves a number of organizations within the DOE and the DOD community, including interactions with other DOE laboratories within the CTBT R&D program. Operational issues involve close work with the Air Force Technical Applications Center (Patrick AFB, Florida), the DOD organization that handles monitoring systems. In addition, several active international collaborations with other infrasound researchers are ongoing.

As part of LANL's Crisis Forecasting Initiative, weather and fire behavior models are being combined to predict the progression of wildfire events. This project requires the advanced computational capabilities found at LANL via the ASCI Program, and also the combined modeling suite of the Regional Atmospheric Modeling System (RAMS), HIGRAD, and FIRETEC, a very-high-resolution, chemically interactive, fire prediction code. Another example of this multi-model approach is part of the Transport and Fate thrust area of the new (1997) multi-laboratory DOE Chemical Biological Non-Proliferation Program. The group is developing a continuum approach to simulating the spread of potential toxins from the interior of buildings out to street and building complexes, then over an entire urban region for a range of anti-terrorism applications.

On global scales, research within the LANL meteorological community involves the study of climate change and variability. A major project is the development of a global coupled ocean-atmosphere model sponsored by the DOE Climate Change Prediction Program. The global model being developed consists of a Los Alamos global ocean GCM (Parallel Ocean Program (POP)), the Los Alamos sea-ice model (CICE), the NCAR Community Climate Model (CCM3), and a "flux coupler" to link the media consistently. The two GCMs and the CICE model exchange heat, momentum, and water mass across the air-sea boundary. A 10-year synchronized simulation revealed the synoptic weather events, seasonal cycles, and interannual variations.

Observations related to understanding global climate are the focus of the Tropical Western Pacific (TWP) Program Office LANL, an element of the DOE's ARM Program. The TWP Program Office is responsible for the development and operation of the TWP CART locale, a large expanse of tropical ocean and maritime continent lying roughly between 10° S and 10° N latitude and from 135° E to 150° W longitude. The maritime continent area is largely in the southwest and the open ocean area in the northeast of the locale. Climatologically, the locale is characterized by warm sea surface temperatures, deep and frequent atmospheric convection, high rain rates, strong coupling between the atmosphere and ocean, and substantial variability associated with El Niño-Southern Oscillation (ENSO) phenomenon. Scientific questions that need to be addressed in the TWP can be grouped under three main headings: (1) radiation budget and cloud forcing, (2) water and energy budgets, and (3) ocean-atmosphere interactions.

The program supports a variety of operations at Los Alamos. The primary client of the program is the Emergency Management Group, for which the program provides a plume modeling capability. Other clients use the program's data for such activities as operations and planning, hazard and accident analyses, environmental studies, support for experiments, compliance, and documentation.

The Pantex Plant, under the responsibility of the Amarillo Area Office, is America's only nuclear weapons assembly and disassembly facility. Located on the High Plains of the Texas Panhandle, 17 miles northeast of Amarillo, Pantex is centered on a 16,000 acre plot located in Carson County. The Pantex Plant industrial operations are conducted for the Albuquerque Operations Office by a management and operating contractor (Mason & Hanger), the United States Army Corps of Engineers (COE), and SNL. The Pantex Plant is composed of several functional areas including a weapons assembly/disassembly area, a weapons staging area, an area for experimental explosive development, a drinking water treatment plant, a sanitary waste water treatment facility, and vehicle maintenance and administrative areas. Other functional areas include an explosive test-firing facility, a burning ground for burning explosive materials, and areas for landfill and storage.

The Environmental Protection Department (EPD) performs the quality assurance for the meteorological data captured by the one on-site tower. EPD also maintains the climatology database and acts as the subcontractor technical representative for the Meteorology and Calibration contract. No activities are planned at Pantex for FY 1999 as well as no plant-level, meteorological support or services through the Operations Center. There are no current or projected supporting research activities planned at Pantex.

The Risk Management Group applies the data collected from the meteorological tower for Dispersion Analyses required for the Basis for Interim Operations (BIO) reports, other operations directives, and other safety analyses. Work involving meteorology for plume dispersal modeling is applied to the Plutonium Dispersal Consequence Analysis for the BIO validation and upgrade.

The Savannah River Site (SRS) is under the responsibility of the Savannah River Operations Office (SR) and operated by the Westinghouse Savannah River Company (WSRC). SRS is located in

southwestern South Carolina, along the banks of the Savannah River. The SRS covers an area of approximately 300 square miles. It is heavily vegetated with evergreen trees and contains many streams, a swamp, and a 2,700 acre reservoir built as a cooling pond for the plant reactors. The topography of SRS is characterized by gently rolling forested hills with an adjacent flood plain near the Savannah River. The climate at SRS is typical of the southeastern United States with long, hot and humid summers and short mild winters.

The Atmospheric Technologies Group (ATG) of the Savannah River Technology Center (SRTC) developed the SRS meteorological monitoring and modeling program in the early 1970's. This program supports the SRS operations in the areas of emergency response consequence assessment, radiological and non-radiological air quality calculations for regulatory compliance, safety analyses, environmental impacts, engineering studies, environmental research and nonproliferation activities.

Meteorological activities include daily weather forecasting services in support of operations at SRS, with particular emphasis on severe weather impacts. Local meteorological data are obtained from a network of eight 200-foot meteorological observing towers located near the major production sites. The instrumentation on these towers include sensitive bi-directional vanes (bivanes), cup anemometers, resistance thermometers, and lithium chloride humidity sensors. Additional meteorological instrumentation is located at the Central Climatology Facility located near the geographical center of the site to measure precipitation, evaporation, barometric pressure, soil temperature, and solar and long wave radiation. Central Climatology includes a 200-foot tower instrumented at four levels. Nearby, a 1,000 foot TV tower is instrumented at seven levels. A network of twelve additional rain gages (that are read daily) is located within SRS. Additional local upper-air data are collected from three acoustic Doppler radars, a Beukers rawinsonde system, and an airsonde and tethersonde system. Portable towers are used for case studies.

A collaborative agreement with surrounding counties involves assisting them to install and operate several local meteorological towers at nearby chemical plants. Data from these towers are being integrated into the SRS meteorological archiving and display system the Weather Information and Display System (WINDS). WINDS is the primary consequence assessment system for atmospheric and hydrologic releases from SRS operations. A suite of atmospheric models linked to real-time site wide atmospheric monitoring provides transport, dispersion, and consequence calculations for emergency response. An aqueous model is also resident on WINDS and linked to real-time stream flow monitors operated by the USGS. This model enables consequence assessments for emergency response to site streams and the Savannah River.

Regional, national, and international meteorological data are received from a commercial weather data provider via satellite in real-time. Weather workstations provide surface and upper observations, analyzed and forecast weather parameter fields from the NWS and the European Modeling Center. These data are input into an advanced, 3-dimensional, prognostic, atmospheric modeling system for applications locally in the southeastern United States and globally. Satellite and Doppler radar data are also available in near real-time.

The Rocky Flats Environmental Technology Site (RFETS) is managed by the Rocky Flats Operations Office and is located approximately 16 miles northwest of downtown Denver, Colorado. One of DOE's smaller sites, the facility occupies a 10 square mile area along the foothills of the Rocky Mountain Front Range. Meteorological services are provided by contractors under the Integrated Site Contract for the facility. Merco, Inc. conducts meteorological monitoring for general operations support to the site.

A 61m meteorological tower at the west end of the site continuously monitors meteorological conditions at surface, 10m, 25m, and 60m above ground level. A back-up, 10m tower is located nearby to ensure 100 percent data recovery. The data are analyzed, quality assured, and assembled into data sets for use in atmospheric modeling, climatology, and other analyses at the site. Data from the 61m and 10m towers are also telemetered back to the main site every 15 minutes for use in emergency response modeling. The Regional Atmospheric Response Center conducts meteorological activities associated with emergency preparedness and response at the site. An upper air remote sensing Sound Detection and Ranging/Radio Acoustic Sounding System (SODAR/RASS) continuously monitors winds, temperatures, and atmospheric stability above RFETS.

Through a cooperative agreement with the Colorado Department of Public Health and Environment, meteorological data are telemetered to the site from five surface meteorological stations that ring the site perimeter. Another cooperative agreement with NOAA provides near real-time data from multiple monitoring sites throughout the Denver metropolitan area. These data are all received, quality assured, and combined into a 3-dimensional observation set for emergency response modeling every 15 minutes, 24 hours per day.

The Regional Atmospheric Response Center provides 24 hour consequence assessment support for any unplanned radiological or chemical releases from the site. The center responds with customized weather forecasts, plume projections, and dose modeling results

that lead to event classifications and protective actions for on-site and off-site populations. The Regional Atmospheric Response Center also conducts specialized consequence assessments in support of emergency preparedness hazards assessments and risk assessments for RFETS. Weather forecasts are provided for severe weather events, such as winter storms, wind storms, and severe thunderstorms.

A customized modeling system has been developed and implemented at RFETS to predict the path and impacts from any radiological emergency at the site. Called the Computer-Assisted Protective Action Recommendation System (CAPARS), the new capability addresses the need for fast, accurate plume predictions in a complex atmosphere.

CAPARS provides a variety of plume, weather, hazard, and related products with the accuracy and speed needed for response to an emergency at RFETS. Eleven major subsystems work together to form the overall CAPARS capability. The State of Colorado has formally accepted the CAPARS modeling system for emergency response and planning applications at RFETS. A specialized planning version of the CAPARS system has been developed, implemented, and applied for emergency planning at the RFETS. Called the TRAC Risk Assessment/Hazards Assessment Model, the capability is designed to support hazards and risk assessments for RFETS and to form the basis for an evaluation of the size and shape of the Emergency Planning Zone surrounding RFETS.

Meteorological services to the Richland Operations Office and the Hanford Site has been provided for more than 50 years with the last 32 years by Battelle's Pacific Northwest National Laboratory (PNNL). Not only has operational support been provided, but also supporting research into atmospheric processes has been a key part of PNNL's support to DOE Richland. The facility covers 560 square miles within the arid and sparsely vegetated Columbia River basin in southeastern Washington. Key DOE research activities at PNNL's Atmospheric Sciences and Global Change Resources Department include GCRP, ARM, the Atmospheric Chemistry Program (ACP), the Core Carbon Dioxide Research program, the Computer Hardware Advanced Mathematics and Model Physics (CHAMMP) program, and the Mexico City Air Quality Study.

GCRP focuses on the study of basic geophysical processes and on the development of databases that are critical for understanding global and regional climatic change. The ARM program is designed to characterize empirically the radiative processes in the atmosphere with high spatial, temporal, and spectral resolution and accuracy at four to six climatologically important sites distributed worldwide. The goal of the CHAMMP program is to produce a climate modeling system having 10,000 times the capacity of the current generation of models and computers. In addition, carbon dioxide emissions research is aimed at providing a scientific basis for forecasting future emissions of carbon dioxide and other radiatively important gases.

PNNL's Meteorological and Climatological Services Project (MSCP) office provides meteorological monitoring and operational support. The monitoring system consists of an array of twenty-six 10m towers, three 60m towers, and one 125m tower instrumented with temperature and wind direction and speed sensors. Atmospheric pressure and precipitation data are also collected. Data from this network are transmitted via UHF radio to a computer that decodes the data and plots graphics products for immediate display and use by Hanford Meteorological Station personnel. Other meteorological data are received via the NWS/DOE AFOS network. Meteorological services include emergency response functions, weather forecasting for on-site operations and special projects, and climatological support. MSCP support to the Hanford site includes: (1) extensive data acquisition via a site-wide meteorological monitoring network, (2) weather forecasting services 24-hours/day Monday through Friday, and 8-hours/day on weekends and holidays, (3) hourly surface observations, and (6) hourly synoptic observations, and (4) monthly and annual climatological data summaries, plus meteorological input to annual environmental reports.

Brookhaven National Laboratory (BNL), under the responsibility of the Brookhaven Area Office, has been active in both operational meteorology and atmospheric sciences for the past 50 years. BNL is now managed by the Brookhaven Science Associates (BSA) which is a joint venture by Battelle Memorial Institute Inc., The Research Foundation of the State University of New York at Stony Brook, and six other core university partners. Meteorological operations and research cover a wide range of programs encompassing interpretive and theoretical studies. BNL is located near the geographical center of Long Island, New York. Long Island is glacial in origin and, as a result, has sandy soil, mostly gentle undulating contours, and a single water aquifer for the entire island. Elevations vary between 20m and 35m. BNL's site is rectangular and approximately 5,200 acres in area. Winds are predominantly southwesterly, and plume dispersion studies show that it is essential to monitor winds well beyond laboratory borders. The NWS New York City Weather Forecast Office is located at BNL. This office has an umbrella of coverage that includes an estimated population of 17 million. Nearby, in Bohemia, is the NWS Eastern Regional Headquarters which administers a 12 state region (Figure 3–DOE–1).

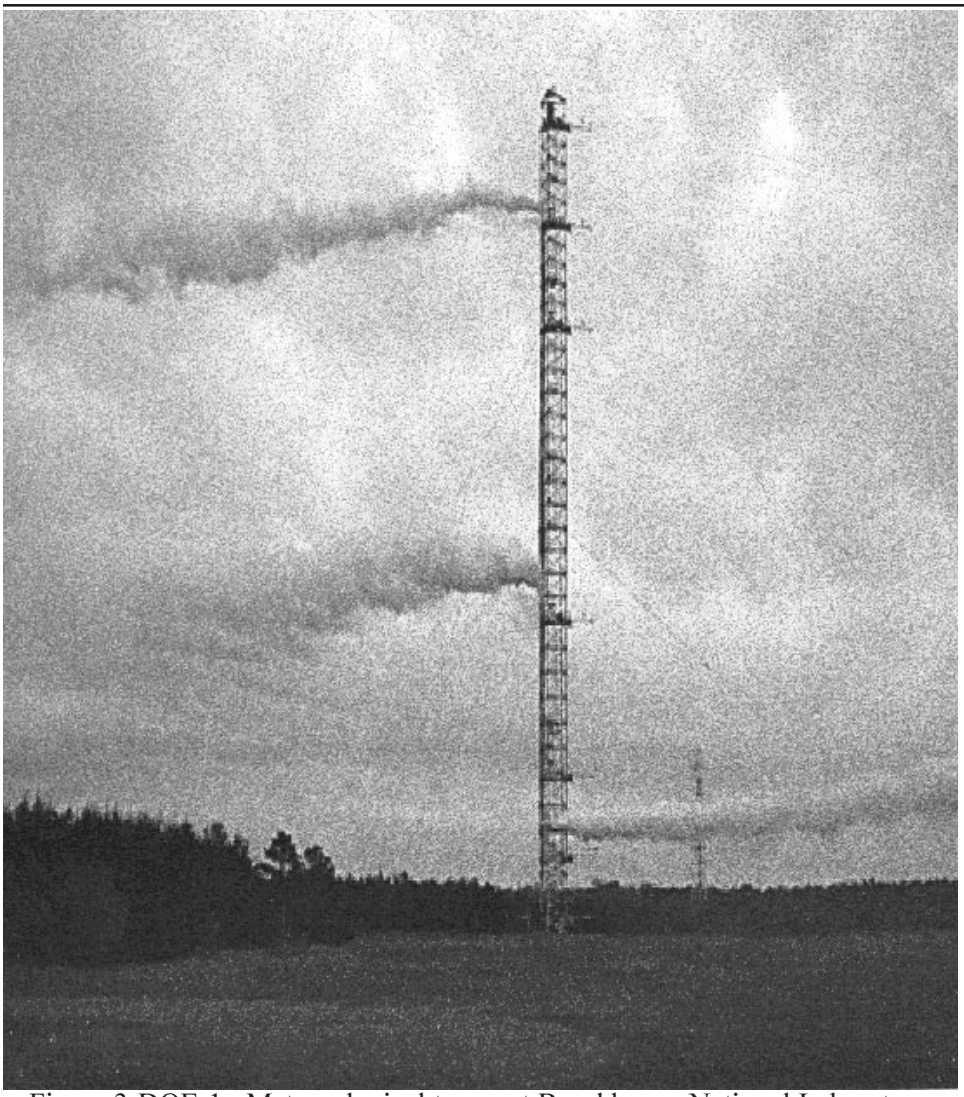

Figure 3-DOE-1. Meteorological tower at Brookhaven National Laboratory monitors near-surface dispersion of pollutants--plumes indicate wind blowing in three directions at different heights above the ground.

The mesoscale meteorological measurements necessary for emergency response are the responsibility of the Meteorological Services Group, a support group under the Department of Applied Science, Environmental Biology and Instrumentation Division (EBID). The Meteorological Services Group maintains two meteorological towers, 10m and 88m, and an instrument shelter. By integrating redundant pairs of standard, approved meteorological sensors throughout the system, an overall data availability of better than 99 percent is achieved. The real-time data are merged into the laboratory emergency response network. A database of 50 years (in digital format since 1960), one of the longest continuous meteorological time series in the United States, is archived and is available. A real-time monitoring network with worldwide web access covers the east end of Long Island. Coastal weather stations at Smith Point and Orient Point transmit data each minute. Pollution-monitoring data buoys are added during field programs.

The Meteorological Services Group provides a locally tuned forecast twice daily during normal working hours. Weather forecasts and data are available by telephone or the Internet (*www.weather.bnl.gov*). During severe weather events, updates are given every 3 hours and, in the case of a hazardous material or radiological release, a member of the Meteorological Services Group will assist the emergency coordinator with regular forecasts and information on local wind fields and gustiness. Areas of meteorological research include: (1) instrumentation development for field studies of atmospheric constituents, air-sea interaction, and laboratory experiments, (2) gaseous tracer studies of atmospheric transport and dispersion, (3) aerosol formation and behavior, (4) atmospheric pollution studies, (5) modeling of atmospheric chemical reactions, (6) acid rain studies both in the field and in the laboratory, (7) theoretical and observational studies of radiative transfer and fluxes, and (8) analysis of data and development of parameterizations relevant to global climate change.

The ARM Program provides the stimulus for a wide range of climate-related studies. The ARM ocean monitoring program is developing instrumentation and a broad ship- and buoy-based observational network in the tropical western Pacific Ocean. The Atmospheric Chemistry Division is concerned with aerosol sources, transport, and fate in the global atmosphere and the overall, and little understood, impact of aerosols on global climate dynamics. The ARM External Data Center is the center for collection, archival, and dissemination of all climate-related data sets for the ARM program. An exciting new effort in radar meteorology focuses on algorithms for cloud detection and cloud mapping using both the WSR-88D radar network and research radars. BNL is a site in the NASA Solar Irradiance Network and continuous shortwave absorption measurements are made here. In a related NASA study, oceanic aerosol optical depths are measured and used to validate absorption algorithms in the SeaWiFS ocean color program.

The Optical Remote Sensing group within the Department of Advanced Technology is presently modifying one of its Raman lidar systems for vertical

profiling of carbon dioxide. The Raman lidar instrument is a self-calibrating sensor which means that data from a variety of locations in the world can be compared. With the incorporation of a large (1.25m) antenna and advanced filters and detectors, a vertical profile of CO_2 concentration with a precision of 1 ppm (atmospheric mean = 370 ppm) and maximum height of 2-3 km can be produced routinely. These profiles will support model development and validation. Importantly, comparison of CO_2 concentrations collected throughout the world and over time will prove invaluable in confirming adherence to the Kyoto protocols.		